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Google Scholar, Lens et WoS

Cummings, B. E., Haas, C. N., Lo, L. J., Sales, C. M., Fox, J., Waring, M. S.
Airborne disease transmission risks on public transit buses: Impacts of ridership, duration, and mechanical filtration using a relative risk metric.
Building and Environment, Vol. **255**, (2024)

Although public transportation vehicles often provide reasonable amounts of ventilation and air filtration, their small volumes and the close proximity of passengers may cause them to be significant sites of airborne disease transmission. Since the COVID-19 pandemic, several studies have investigated such risks on public transit vehicles for specific well-constrained case studies. This study generalizes these efforts by benchmarking the statistical bounds of relative airborne transmission risks onboard transit vehicles independently of a disease's particular infectivity and prevalence in a community. We examined which factors drive relative onboard transmission risks and compared these risks to those of other common indoor environments and activities, using a novel adaptation of the Wells-Riley method for modeling indoor airborne infection risks. Specifically, simulations were evaluated for five different HVAC scenarios and were carried out for a domain representing three rapid transit bus routes in Southeastern Pennsylvania using empirical ridership and schedule data provided by the region's transportation authority. From these simulations, continuous fan operation using a MERV 13 filter were modeled to reduce risks approximately fivefold compared to intermittent fan operation (25% runtime) and 1-2 orders of magnitude less as compared to no HVAC recirculation and filtration, highlighting the need for mechanical system upgrades and regular maintenance for transit vehicles. By comparing relative risks between activities done in different indoor environments on both a per-time and per-activity basis, our results demonstrate that riding transit buses with fully operational filtration systems poses less risk, on average, than indoor dining and office work.

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Park, H.-E., Go, S., Song, Y.-H.
Airflow and Pressure Design Review of Modular Negative Pressure Wards.
Buildings, Vol. **14** n°(6), (2024)

In the aftermath of the COVID-19 pandemic, the urgent need for the rapid deployment of healthcare facilities propelled the rise of modular construction using an infill approach. In these modular, negative-pressure wards, the design of indoor airflow and pressure plays a crucial role in meeting the ventilation strategies required for isolation facilities. Accordingly, this paper focuses on modular negative-pressure wards employing an infill construction method and proposes an appropriate spatial pressure distribution to address the problem of air tightness degradation due to leakage. This study analyzed the indoor airflow and pressure distribution of a unit module corresponding to an infill. It aimed to examine whether the pressure difference with the adjacent room is maintained and to assess its effectiveness in isolating contaminated air. First, the airflow rate of the heating, ventilation, and air conditioning system in the unit module was calculated to ensure that it would meet the performance criteria of the negative-pressure ward. Afterward, based on the calculated rate, the study assessed the airflow and room-specific pressure within a typical floor, encompassing both the unit module and associated nursing support facilities. Here, the airflow in the external corridor of the typical floor was divided into two cases according to the pressure distribution: negative pressure and atmospheric pressure. The calculation results were compared using a computational fluid dynamics tool. The analysis results confirm that the air isolation performance is adequate as the pressure difference between adjacent rooms in the unit module and the typical floor was maintained at 2.5 Pa. Additionally, the indoor airflow in the negative-pressure isolation room formed a stable flow at a slow speed of 0.1–0.2 m/s,

minimizing the possibility of air contamination from outside the isolation room. In particular, Case B of the typical floor design proposes a method to optimize the pressure distribution in the modular negative-pressure ward by designing the ventilation flow rate at atmospheric pressure level. Thus, this study emphasizes that atmospheric pressure design is appropriate when designing pressure in areas where negative-pressure control is difficult and can contribute to the design and improvement of similar medical facilities in the future.

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Luo, Q., Deng, X., Hang, J., Ou, C., Luo, Z., Fan, X.*, et al.*
Assessing impact of intermittent window opening strategies on pathogen-laden droplet dispersion in a coach bus.
Building Simulation, (2024)

Opening windows in coach buses is a practical approach to improving natural ventilation and mitigating infection risk (IR). Due to human behavior and weather conditions, the intermittent window opening strategy (IWOS) is a more common practice than keeping windows constantly open. Despite its prevalence, there are no studies exploring IWOS specifically in vehicles. We employed indoor-outdoor coupled CFD simulations to assess the effects of various IWOS on pathogen-laden droplet (PLD) dispersion and IR in a coach bus that occurred a COVID-19 outbreak in Hunan, China. Results reveal that after ventilating through two skylights for 600–1800 s, opening front and rear windows (FW+RW) or FW with a wind catcher (FW+WCH) for just 40 s can reduce PLD concentration (Cave) to 5% of its initial level and the intake fraction of the infector's neighbor (IFn) drops by 95%. Upon closing FW+RW or FW+WCH, Cave and IFn take over 580 s to return to the pre-opening level. Moreover, intermittent FW opening halves Cave and IFn within 7 min, but leads to rapid increases upon window closure. Therefore, opening FW+RW and FW+WCH intermittently have pronounced impacts on indoor PLD concentration and are applicable approaches to control respiratory disease transmission in vehicles. According to the inhaled viral dose, it is recommended to open windows when driving time is over 12 minutes to reduce infection risk. In scenarios like epidemiological surveys and risk assessments, where assessing passenger infection risk is vital, some behaviors of opening windows cannot be overlooked and necessitate extra attention.

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Tantasavasdi, C., Rianngon, T., Inprom, N.
CFD Assessment of COVID-19 Infection Risk in Naturally Ventilated Detached Houses.
Nakhara : Journal of Environmental Design and Planning, Vol. **23** n°(2), (2024)

The airborne nature of COVID-19 dispersion has considerably impacted architectural and ventilation system designs. This research studies the COVID-19 infection risk in typical naturally ventilated detached houses in Thailand. Influencing parameters include the opening size and location of the infected person. Computational Fluid Dynamic was used to simulate the virus spreading in major spaces including the master bedroom, a bedroom and the living room. The Wells-Riley equation was adopted to assess personal infection risk (Pp) and area infection risk (Pa) in 12 case setups. The results reveal that opening size affects more on Pa than Pp. Increasing the opening-to-floor ratio in the range of 0.03 to 0.28 will reduce the Pa and Pp ratios in the range of 0.03 to 0.13 and 0.01 to 0.12, respectively. The location of the source, however, impacts more on Pp than Pa ratios. It varies the trend of the infection risk in the range as high as 0.69 to 0.70 according to other factors including the location of other occupants and the outlet openings.

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Kang, L., Qin, P., Diepens, J., Van Hooff, T., Loomans, M. G. L. C.
CFD-aided ventilation design for a large experimental chamber to study aerosol dispersion and removal.
RoomVent 2024 conference: Healthy air together - when scientific and industrial advances meet the needs of society - Stockholm, Sweden. 22-25 Apr 2024

To aid the design of a new large experimental chamber with a mixing ventilation system, computational fluid dynamics (CFD) simulations were employed in assessing the ventilation performance with different configurations of supply and exhaust positions, as well as the introduction of a plate beneath the supply openings to facilitate attachment of the supplied air to the ceiling. The simulation results indicate that a crossed configuration enhances air mixing within the experimental room in the investigated chamber (9.910 m × 6.729 m × 2.995 m) compared to a parallel configuration of supply openings. In addition, incorporating a plate with a small gap between the ceiling supplies and the ceiling effectively reduces maximum velocities in different zones of the room, which is better to avoid draught issue and improve distribution uniformity. The CFD simulations offer insights into the important effect of supply and exhaust design on the flow pattern in the experimental chamber. Future research in this room is directed at analyzing these effects further, also in combination with, e.g., furnishing and use of air cleaners.

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Dewanto, I., Sari, C. W., Dewi, A.
The contamination of aerosols and splatters in dental practice during Covid-19 pandemic.
AIP Conference Proceedings, Vol. **3127** n°(1), (2024)

Aerosols, droplets, and splatters are generated throughout dental treatment. New research has found that the viability of SARS-CoV-2 virus indicates infectious aerosols can persist for several hours and on surfaces for 2 days. The aim of this study was to determine whether there is aerosol contamination and splatters on dentists and their work environment after dental treatment performed using blacklight visualization. This research design is descriptive analytic with observational method conducted at UMY Dental Hospital. The samples of this study were 80 dental procedures. Observations were made before, during, and after dental treatment. The authors ensured there was no contamination before the procedures and the contamination after the procedures were thoroughly cleaned, and there was no contamination remained before other patients arrived. Contamination discovered on participant's facial protective barrier was on the inner corner of the eye (62.9%). Chest (7.5%), abdomen (7.5%), right upper limb (7.5%), left upper limb (1.25%), right lower limb (1.25%), left lower limb (1.25%). Contamination of non-surgical gown A (24%), B (35%), C (13%), D (0%), dentist chair (0%), separator (35%), handpiece (66%), saliva ejector (90%), three-way syringe (60%), bowl rinse (100%), dental chair (5%), tray (51%), dental light (60%), foot control (19%), cuspidor unit (35%). The most contamination on the face was at the right inner corner, chest, abdomen, right upper limb, both sleeves of medical gown, dental unit on rinse bowl. Dentists have a high risk of exposure to Covid-19 from aerosols and splatters contamination on the face.

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Martinot, M., Mohseni-Zadeh, M., Gravier, S., Eyriey, M., Ongagna, J., Henric, A.*, et al.*
Covid-19 nosocomial : fréquence, mortalité, rôle de l'architecture et de la ventilation.
Médecine et Maladies Infectieuses Formation, Vol. **3** n°(2, Supplement), (2024), S113 p.

Introduction Le début du XXIe siècle a été marqué par 4 pandémies : le SRAS-CoV-1 (2003), la grippe H1N1 (2009), le MERS- CoV (2012) et plus récemment, SRAS-CoV-2 (2019). L'ampleur de la pandémie du SRAS-CoV-2 a souligné l'inexactitude et les limites des mesures précédentes de prévention des précautions complémentaires notamment en cas de risque aéroporté. La dichotomie gouttelettes-air en particulier est inexacte dans les environnements intérieurs. Nous sommes intéressés à la fréquence des cas nosocomiaux de COVID-19 (NC) en période pré-Omicron et Omicron et au rôle de l'architecture et de la ventilation dans l'émergence de ces cas. Matériels et méthodes Tout patient avec COVID-19 confirmé (PCR+) hospitalisé dans notre centre (>24h) durant la période pré Omicron (PO) du 01/03/20 au 31/10/21 puis Omicron (O) du 01/12/21 au 30/09/22 a été inclus. La survenue d'un NC sein de notre établissement a été défini par la survenue d'un cas après 48h d'hospitalisation. Dans un deuxième temps pour la période PO nous avons

comparé en terme de fréquence de survenue des NC au sein de notre institution un hôpital moderne mère enfant et réanimation (HM) (ventilation avec apport d'air frais mécanique, taux de renouvellement d'air (RA) =2 et 91% de chambre seules) et un hôpital historique médico-chirurgical (HH) (ventilation naturelle, RA < 1 et 53% de chambre seules). Résultats Pendant la période d'étude, 2932 patients ont été hospitalisés (>24H) avec un COVID19 confirmé (PCR+) : 1690 (PO) et 1242 (O). Les cas nosocomiaux représentaient 487 cas (16.7 %) dont 261 (15.4 %) en période (PO) et 226 (18.2 %) en période O (p=0.05). La mortalité des cas nosocomiaux était de 26,1% (PO) et 16.4 % (O), >un taux supérieur à la mortalité globale de chaque période 16 ,9% (PO) et 11% (O). Du 1/10/20 (date de mise en place d'un screening COVID-19 systématique pour toute hospitalisation) au 31/5/21 33,718 patients ont été hospitalisés > 24H dont 25,038 patients dans HH (74.3%) et 8680 dans HM (25.7%) avec une DMS respective de 5.5 et 4.7 jours. 1020 COVID-19 ont été diagnostiqués dont 1P50 NC, 149 (99,3%) ont été diagnostiqués dans HH versus 1 dans HM (p<0.001). 73 cas sont survenus dans une chambre seule versus 77 dans une chambre double dont 26 cas secondaires. Conclusion Les NC sont un marqueur du contrôle des infections aéroportées ; la fréquence est importante et la mortalité non négligeable même en période O. Bien que dans notre étude les populations de HM et HH diffèrent la quasi absence de NC dans HM durant la période évaluée souligne le rôle protecteur de l'architecture et de la ventilation. L'acquisition de NC dans HH a été favorisée par une contamination de proximité (chambre à 2) mais aussi potentielliement par une contamination aéroportée à distance liée à une ventilation insuffisante. Les infectiologues devraient connaitre au sein de leur établissement et de leur service les modes de ventilation (ventilation mécanique versus ventilation naturelle), le RA, les flux aériens et connaitre les mesures d'amélioration pour éviter les contaminations aéroportées à distance particulièrement en cas de ventilation naturelle.

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Jo, D.-H., Kim, S., Roh, J., Paik, D., Kim, M.
Development of PCM Color Coated Steel Sheets with Excellent Antiviral and Antimicrobial Properties.
Corrosion Science and Technology-Korea, Vol. **23** n°(2), (2024), 139-144 p.

Recently, due to the rapid spread and continuation of COVID-19, customer demand for health and hygiene has increased, requiring the development of new products that express antiviral and antibacterial properties. In particular, viruses are much smaller in size than bacteria and have a fast propagation speed, making it difficult to kill. POSCO has developed eco-friendly PCM color coated steel sheets with excellent antiviral properties by introducing inorganic composite materials to the color coating layer on the surface of Zn-Al-Mg alloy plated steels. The virus is not only destroyed by adsorption of metal ions released from the surface of the coating film, but is also further promoted by the generation of reactive oxygen species by the reaction of metal ions and moisture. As a result of evaluating the developed products under the International Standard Evaluation Act, the microbicidal activity was 99.9% for viruses, and 99.99% for bacteria and 0% fungi. In particular, excellent results were also shown in the durability evaluation for life cycle of the product. The developed product was applied as a wall of school classrooms and toilets and ducts for building air conditioning, resulting in excellent results. Developed products are being applied for construction and home appliances to practice POSCO's corporate citizenship.

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Tan, Q., Song, J., Fu, H., Liu, S., Sun, Z., Zhang, S.*, et al.*
Diffusion Risk Analysis and Interdiction Procedures of Transmission of Microorganism in the Primary Cold Storage of Imported Cold Chain Food in Case of Novel Coronavirus.
International Journal of Refrigeration, (2024)

ABSTRACT During the period of COVID-19, the health problems caused by the contamination of imported cold chain food by pathogenic microorganisms attracted widespread attention, which brought new risks and challenges to cold chain products. The traditional liquid disinfection method has obviously been unable to meet the existing disinfection and sterilization needs, and establishing a complete set of cold chain product

disinfection system has become the focus of research. This paper takes the process of importing cold chain food from Tianjin's primary cold storage as an example, and proposes the closed-loop cold storage disinfection system of "Human-Cargo-Apparatus-Waste". The establishment of the disinfection system determined the working characteristics of different areas of the primary cold storage and the risk level of virus transmission through on-site analysis and simulated aerosol diffusion experiments. According to the characteristics of different working areas in the cold storage, targeted sealing measures and disinfection techniques are adopted. It can effectively ensure the complete disinfection of cold chain products and avoid the negative impact of disinfection and sterilization methods. The expected research results provide certain technical support for the development and application of safe virus elimination throughout the entire process of imported cold chain.

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Paddy, E. N., Afolabi, O. O. D., Sohail, M.
Exploring toilet plume bioaerosol exposure dynamics in public toilets using a Design of Experiments approach.
Scientific Reports, Vol. **14** n°(1), (2024)

Bioaerosols generated during toilet flushing can contribute to the spread of airborne pathogens and cross-contamination in indoor environments. This presents an increased risk of fomite-mediated or aerosol disease transmission. This study systematically investigated the factors contributing to increased bioaerosol exposure following toilet flushing and developed an empirical model for predicting the exposure-relevant bioaerosol concentration. Air in a toilet cubicle was sampled by impaction after seeding with Clostridium difficile spores. Design of Experiments (DoE) main effects screening and full factorial design approaches were then employed to investigate the significant factors that heighten the risk of exposure to bioaerosols post-flush. Our findings reveal that the inoculated bacterial concentration (C), time elapsed after flushing (t), lateral distance (d), and mechanical ventilation (v) are significant predictors of bioaerosol concentration, with p-values < 0.05. The interaction term, C × d showed a marked increase in bioaerosol concentration up to 232 CFU/m3 at the closest proximity and highest pathogen load. The interplay of C and t (C × t) demonstrated a time-dependent attenuation of bioaerosol viability, with concentrations peaking at 241 CFU/m3 immediately post-flush and notably diminishing over time. The lateral distance and time post-flush (d × t) interaction also revealed a gradual decrease in bioaerosol concentration, highlighting the effectiveness of spatial and temporal dilution in mitigating bioaerosol exposure risks. Furthermore, there is an immediate rise in relative humidity levels post-flush, impacting the air quality in the toilet environment. This study not only advances our understanding of exposure pathways in determining bioaerosol exposure, but also offers pivotal insights for designing targeted interventions to reduce bioaerosol exposure. Recommendations include designing public toilets with antimicrobial surfaces, optimizing ventilation, and initiating timely disinfection protocols to prioritise surfaces closest to the toilet bowl during peak exposure periods, thereby promoting healthier indoor environments and safeguarding public health in high-traffic toilet settings.

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Tang, L., Wang, D., Sun, S., Cheng, Q., Zhang, L., Xia, W.*, et al.*
Fiber-in-Tube Electrifiable Structure for Virus Filtration Self-Generated Static Electricity by Vibration/Sound.
Acs Applied Materials & Interfaces, Vol. **16** n°(19), (2024), 25160-25168 p.

Fiber has been considered as an ideal material for virus insulation due to the readily available electrostatic adsorption. However, restricted by the electrostatic attenuation and filtration performance decline, their long-lasting applications are unable to satisfy the requirements of medical protective equipment for major medical and health emergencies such as global epidemics, which results in both a waste of resources and environmental pollution. We overcame these issues by constructing a fiber-in-tube structure, achieving the robust reusability of fibrous membranes. Core fibers within the hollow could form generators with tube walls

of shell fibers to provide persistent, renewable static electricity via piezoelectricity and triboelectricity. The PM0.3 insulation efficiency achieved 98% even after 72 h of humidity and heat aging, through beating and acoustic waves, which is greatly improved compared with that of traditional nonwoven fabric (similar to 10% insulation). A mask spun with our fiber also has a low breathing resistance (differential pressure <24.4 Pa/cm(2)). We offer an approach to enrich multifunctional fiber for developing electrifiable filters, which make the fiber-in-tube filtration membrane able to durably maintain a higher level of protective performance to reduce the replacement and provide a new train of thought for the preparation of other high-performance protective products.

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Kim, C.
Field Study of Ventilation Planning in Multi-Use Facilities for the Post-COVID-19 Pandemic Era - Focusing on Facility Usage Conditions and Ventilation Performance.
KIEAE Journal, Vol. **24** n°(2), (2024), 87-95 p.

Purpose : This study aims to improve the ventilation performance of multi-use facilities based on a field study for the preparedness in the post-COVID-19 era, which can assist the advances on ventilation systems against airborne infectious diseases. Method : To analyze the potential weakness of airborne infections in multi-use facilities, a field study was conducted in 20 locations (i.e., 2 cafes, 9 restaurants, 3 indoor sports facilities, 2 PC cafes, and 1 supermarket) in Busan, Korea. The physical conditions, usage profiles and behaviors, architectural design, HVAC system, and ventilation planning standards were analyzed. Based on this, recommendations for ventilation planning were proposed for multi-use facilities during the post-pandemic era. Result : In this study, a field study diagnosed the ventilation planning of multi-use facilities and reviewed the obstacles and developed future directions to prepare for the air contaminant outbreaks. The results showed that In existing multi-use facilities, it is required to improve ventilation performance based on a multifaceted investigation considering the nature of the facility. The results will contribute to building preparedness for the next pandemic in multi-use facilities.

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Korhonen, M., Laitinen, A., Isitman, G. E., Jimenez, J. L., Vuorinen, V., Otakaari, M. A.*, et al.*
A GPU-accelerated computational fluid dynamics solver for assessing shear-driven indoor airflow and virus transmission by scale-resolved simulations.
Journal of Computational Science, Vol. **78**, (2024)

We explore the applicability of MATLAB for 3D computational fluid dynamics (CFD) of shear-driven indoor airflows. A new scale-resolving, large-eddy simulation (LES) solver titled DNSLABIB is proposed for MATLAB utilizing graphics processing units (GPUs). In DNSLABIB, the finite difference method is applied for the convection and diffusion terms while a Poisson equation solver based on the fast Fourier transform (FFT) is employed for the pressure. The immersed boundary method (IBM) for Cartesian grids is proposed to model solid walls and objects, doorways, and air ducts by binary masking of the solid/fluid domains. The solver is validated in two canonical reference cases and against experimental data. Then, we demonstrate the validity of DNSLABIB in a room geometry by comparing the results against another CFD software (OpenFOAM). Next, we demonstrate the solver performance in several isothermal indoor ventilation configurations and the implications of the results are discussed in the context of airborne transmission of COVID-19. The novel numerical findings using the new CFD solver are as follows. First, a linear scaling of DNSLABIB is demonstrated and a speed -up by a factor of 3-4 is also noted in comparison to similar OpenFOAM simulations. Second, ventilation in three different indoor geometries are studied at both low (0.1 m/s) and high (1 m/s) airflow rates corresponding to Re = 5000 and Re = 50000. An analysis of the indoor CO 2 concentration is carried out as the room is emptied from stale, high CO 2 content air. We estimate the air changes per hour (ACH) values for three different room geometries and show that the numerical estimates from 3D CFD simulations differ by

80%-150% (Re = 50000) and 75%-140% (Re = 5000) from the theoretical ACH value based on the perfect mixing assumption. Third, the analysis of the CO 2 probability distributions (PDFs) indicates a relatively nonuniform distribution of fresh air indoors. Fourth, utilizing a time -dependent Wells-Riley analysis, an example is provided on the growth of the cumulative infection risk which is shown to reduce rapidly after the ventilation is started. The average infection risk is shown to reduce by a factor of 2 for lower ventilation rates (ACH=3.46.3) and 10 for the higher ventilation rates (ACH=37-64). Finally, we utilize the new solver to comment on respiratory particle transport indoors. A key contribution of the paper is to provide an efficient, GPU compatible CFD solver environment enabling scale-resolved simulations (LES/DNS) of airflow in large indoor geometries on a single GPU designed for high -performance computing. The demonstrated efficacy of MATLAB for GPU computing indicates a high potential of DNSLABIB for various future developments on airflow prediction.

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Li, Z., Ren, Z., Liu, C., Ning, Z., Liu, J., Liu, J.*, et al.*
Heterogeneous variations in wintertime PM _{2.5} sources, compositions and exposure risks at urban/suburban rural/remote rural areas in the post COVID-19/Clean-Heating period.
Atmospheric Environment, Vol. **326**, (2024)

Inevitably, both unblocking of the COVID-19 (UNCOV) and uncertainty in the clean heating policy (2017-2021) in winter 2022 imposed complex impacts on PM2.5 variations. Together, the urban-rural and rural-rural disparities in these impacts remain unclear. To address this gap, we conducted a synchronous observation at urban (UA)/suburban rural (SRA)/remote rural (RRA) areas to probe PM2.5 evolutions in the post COVID-19/clean-heating (PCOV/PCH) period for further site-specific policy implications. Similar meteorological conditions among sites benefited examining the effects of emission variations. On average, PM2.5 presented a decline order as RRA > UA > SRA. Invoking the positive matrix factorization (PMF) results, specially, the primary emissions (PE) rebounded again after experiencing a continuous decline since the stringent emission-control polices initiated in 2013. PE contributions were up to 80.2 %-83.0 % for three points. SRA benefited most from coal-to-gas and coal combustion (CC) has become its minimum contributor (10.8 %). Concurrently, subsidy reduction and natural-gas (NG) shortage compelled biomass burning (BB) to be the largest origin (21.9 %) marked by the highest K+, Cl- and OC/EC. Regarding RRA, CC (26.5 %) and BB (19.6 %) have been the first and second largest origins despite that the coal-to-electricity policy, indicating the slowdown of policy enforcement. The highest SO42-, As, Sb, Tl, OC, EC and the lowest NO3-/SO42- further verified the dominant CC. Production recovery made industrial emissions (IE) become the largest source (26.8 %) at UA. The metal associated health risks peaked at RRA due to large impacts of CC, though the most of metals related to small-scale industries peaked at UA. This is the first work to highlight that more targeted site-specific strategies in prevention/control of dominant primary sources should be formulated in the PCOV/CH period.

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Liu, L., Huang, Y.
HVAC Design Optimization for Pharmaceutical Facilities with BIM and CFD.
Buildings, Vol. **14** n°(6), (2024)

Building Information Modeling (BIM) has been widely used in the past decade to enhance the design quality of Heating, Ventilation, and Air Conditioning (HVAC) systems. However, in specialized areas such as pharmaceutical facilities, HVAC design has traditionally relied on Computer-Aided Design (CAD) drawings. This conventional approach does not allow for the simulation of temperature distribution or the verification of system efficiency, which may lead to design failures. To address these challenges in pharmaceutical facilities, this study proposed a BIM-based approach for optimizing HVAC design with Computational Fluid Dynamics (CFD). By employing CFD to simulate the dynamic airflow conditions of pharmaceutical clean rooms, the effectiveness of HVAC systems can be verified. A case study of a clean room HVAC design is presented to

demonstrate the workflow. The results of the case study indicated that the pharmaceutical temperature requirements were met within 1 °C during the design optimization simulation, and there was a 95% match in the 72 h temperature mapping test during site validation. The results confirmed that using CFD with BIM not only successfully simulates the design intentions of indoor air quality but also suggests HVAC system optimization for the required clean room design. The findings of this paper contribute to the body of knowledge on overcoming the limitations of the traditional CAD-based HVAC design process and provide valuable insights on optimizing HVAC design with BIM and CFD technologies.

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Ashayeri, M., Abbasabadi, N.
A Hybrid Physics-Based Machine Learning Approach for Integrated Energy and Exposure Modeling.
In: Artificial Intelligence in Performance-Driven Design. 2024. 57-79 p.

Summary This chapter introduces a hybrid framework that brings machine learning (ML) and urban big data analytics into integrated modeling of indoor air quality, building operational energy, and ambient airflow dynamics. This holistic approach allows for more effective and accurate simulation results for the design of built environments that prioritize both climate and health considerations. To validate this framework, we undertook a pilot study on a naturally ventilated, large-size office building prototype, as provided by the U.S. Department of Energy. This prototype was hypothetically placed in a densely populated area of Downtown Chicago, IL. For our computations, we employed tools, including EnergyPlus, CONTAM, CFD0, and artificial neural networks (ANNs). The findings highlighted the proposed framework's robust ability to evaluate the effects of building energy efficiency strategies, such as natural ventilation. Additionally, it took into account the indoor concentration of outdoor pollution resulting from the implementation of such strategies. Employing the hybrid approach, we achieved an accuracy characterized by an R -squared value of up to 0.96, facilitated by ANNs. Compared to conventional physics-based simulation methods, the hybrid approach further accelerated the simulation process by up to 200 times. This novel framework offers valuable insights to architects and engineers during early-stage design decisions, enabling them to harmonize occupant health considerations with energy conservation objectives, thereby placing health and well-being at the forefront of decarbonization goals.

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Sharma, S., Bakht, A., Jahanzaib, M., Lee, H., Lee, J., Park, C.*, et al.*
Improvement of indoor air quality using a smart gate that can lessen viral aerosol (MS2 virus) and particulate matter (PM): Experimental findings.
Environmental Engineering Research, Vol. **29** n°(2), (2024)

Fine particulate matter (PM) and viruses have more detrimental impacts on human health when present in an indoor setting than when present in an outdoor environment. With the COVID-19 epidemic, a healthy indoor environment has emerged as a crucial necessity. There are many different cleaning technologies available, but most of them have drawbacks and are challenging to utilize in daily-use indoor venues including workplaces, retail malls, movie theaters, subway stations, and many other locations. We created a portable, smart gate that is simple to use at a commercial level and evaluated it for effectiveness in lowering particulate matter concentrations of various sizes. The results show that 97.76% for PM10, 97.72%PM4, 97.44% for PM2.5, and 96.91% for PM1. reduction. Also, the aerosolized MS2 virus was used to test its ability to decrease viral transmission and the viral reduction efficiency of the smart gate was found around 82%. The experimental results show that the smart gate is better than all the current available cleaning technologies along with its user-friendly and easy use.

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Brown, H.

Indoor Air Quality Matters: COVID, Climate Change, and More.
CounterPunch, (2024)

Indoor air quality has emerged as a critical public health concern, gaining traction amidst growing recognition of its significance in spreading COVID-19 and many other diseases. Though progress has been slow, several recent developments suggest palpable momentum toward addressing indoor air quality. Late last month, Science published an article by over 40 experts extolling the importance of indoor air quality and urging policymakers worldwide to mandate indoor air quality standards in public buildings. Around the same time, the World Health Organization (WHO) took a meaningful step toward acknowledging the airborne spread of COVID-19 by unveiling its new Airborne Risk Indoor Assessment (ARIA) tool. The WHO also released a report last week that revises and expands the organization's position on the mechanics of disease transmission. The report recognizes that many diseases "travel through the air," though it stops short of endorsing concrete safety protocols. In the US, the Advanced Research Projects Agency for Health (ARPA-H) announced a new program to create a scalable platform to monitor and improve indoor air quality in the US. Much work remains to leverage these initiatives fully, but they represent welcome steps in the right direction.

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Yüce, B. E., Kalay, O. C., Karpat, F., Alemdar, A., Temel, Ş. G., Dilektaşlı, A. G.*, et al.*
Investigation of infectious droplet dispersion in a hospital examination room cooled by split-type air conditioner.
Journal of Environmental Health Science and Engineering, (2024)

The novel coronavirus (SARS-CoV-2) outbreak has spread worldwide, and the World Health Organization (WHO) declared a global pandemic in March 2020. The transmission mechanism of SARS-CoV-2 in indoor environments has begun to be investigated in all aspects. In this regard, many numerical studies on social distancing and the protection of surgical masks against infection risk have neglected the evaporation of the particles. Meanwhile, a 1.83 m (6 feet) social distancing rule has been recommended to reduce the infection risk. However, it should be noted that most of the studies were conducted in static air conditions. Air movement in indoor environments is chaotic, and it is not easy to track all droplets in a ventilated room experimentally. Computational Fluid Dynamics (CFD) enables the tracking of all particles in a ventilated environment. This study numerically investigated the airborne transmission of infectious droplets in a hospital examination room cooled by a split-type air conditioner with the CFD method. Different inlet velocities (1, 2, 3 m/s) were considered and investigated separately. Besides, the hospital examination room is a model of one of the Bursa Uludag University Hospital examination rooms. The patient, doctor, and some furniture are modeled in the room. Particle diameters considered ranged from 2 to 2000 µm. The evaporation of the droplets is not neglected, and the predictions of particle tracks are shown. As a result, locations with a high infection risk were identified, and the findings that could guide the design/redesign of the hospital examination rooms were evaluated.

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Capulli, D., Regazzi, R.
Liquid air filtration and continuous monitoring: Customized indoor air quality.
RoomVent 2024 conference: Healthy air together - when scientific and industrial advances meet the needs of society - Stockholm, Sweden. 22-25 Apr 2024

Air treatment in environmental air conditioning systems exposes the system to gases, contaminants, and often biological pollutants that cannot be solved by traditional mechanical filtration, motivating decision-makers to diagnose challenges and develop innovative strategies to mitigate the problem. More and more, in environments with high turnover of people (e.g., hospitals, hotels and shopping centers), fresh air ventilations are avoided and replaced by closed windows air purifier solutions to account for undesirable saturation of the

atmosphere and the presence of pollutants such as PM10, PM2.5, PM1.0, nitrogen, and carbon oxides. The consensus is that polluting gases render the most efficient traditional filters ineffective. The ANSI/ASHRAE 62.1 and EN13779 standards reveal the absence of air treatment technologies that use the wet route in air conditioning systems. This work discusses the liquid air multi-venturi centrifugation technology of hydrodynamic precipitator purifiers in association with the synchronized and continuous monitoring of parameters (PM10, PM2.5, PM1.0, CO2) in the external urban environment and internal environments of a shopping center. It evaluates the performance of the wet route for the physical-chemical and biological treatment of air. Efficiency for retaining particulate matter in a single step without disposable filter reached levels above F9 (85-95% PM2.5), with a reduction of 82.4% for CO2. Wet route technology extends the air conditioner's life, reducing external air flows and energy consumption by up to 13%, making IAQ a manageable and customizable variable. Among the conclusion of the investigation, the authors believe that the migration of industrial pollutant control technologies, such as liquid filtration promoted by gas scrubbers and hydrodynamic precipitators, should be considered as a first choice option due to the high efficiency achieved in the three types of pollutants to be controlled. That is micrometric particulate matter such as anthropogenic PM1.0 capable of reaching the lung alveoli, chemicals such as carbon dioxide and nitrogen, and biological assets such as viruses and bacteria that showed the vulnerability of HVAC-R systems during the COVID pandemic that rendered windowless corporate buildings unusable.

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Ishigaki, Y., Yokogawa, S.
Monitoring the ventilation of living spaces to assess the risk of airborne transmission of infection using a novel Pocket CO2 Logger to track carbon dioxide concentrations in Tokyo.
PLoS One, Vol. **19** n°(5), (2024)

We employed carbon dioxide (CO2) concentration monitoring using mobile devices to identify location-specific risks for airborne infection transmission. We lent a newly developed, portable Pocket CO2 Logger to 10 participants, to be carried at all times, for an average of 8 days. The participants recorded their location at any given time as cinema, gym, hall, home, hospital, other indoors, other outgoings, pub, restaurant, university, store, transportation, or workplace. Generalized linear mixed model was used for statistical analysis, with the objective variable set to the logarithm of CO2 concentration. Analysis was performed by assigning participant identification as the random effect and location as the fixed effect. The data were collected per participant (seven males, four females), resulting in a total of 12,253 records. Statistical analysis identified three relatively poorly ventilated locations (median values > 1,000 ppm) that contributed significantly ($p < 0.0001$) to CO2 concentrations: homes (1,316 ppm), halls (1,173 ppm), and gyms (1005ppm). In contrast, two locations were identified to contribute significantly ($p < 0.0001$) to CO2 concentrations but had relatively low average values (<1,000 ppm): workplaces (705 ppm) and stores (620 ppm). The Pocket CO2 Logger can be used to visualize airborne infectious transmission risk by location to help guide recommendation regarding infectious disease policies, such as restrictions on human flow and ventilation measures and guidelines. In the future, large-scale surveys are expected to utilize the global positioning system, Wi-Fi, or Bluetooth of an individual's smartphone to improve ease and accuracy.

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Scarlett, M., Duffy, B.
A Natural Catalytic Converter® for Continuously Inactivating Air and Surface Pathogens with More Effect than Ventilation and Filtration.
Open Journal of Applied Sciences, Vol. **14** n°(5), (2024), 1353-1363 p.

Study Objective: The purpose of the study is to present independent laboratory testing for a novel technology in air and on surfaces. Since 2020, public health goals have focused on improving indoor air quality. This includes protection from airborne pathogens, such as tuberculosis, RSV, SARS-CoV-2, common cold or

influenza viruses, measles, and others. Engineering controls are highly effective at reducing hazardous pathogens found in indoor air and from recontamination of surfaces. This occurs from a continuous cycle of settling of small, sustained airborne pathogens, which may become dehumidified, becoming airborne again, carried by room air currents around indoor spaces, then repeating the cycle. Methods: The novel technology utilizes a catalytic process to produce safe levels of hydrogen peroxide gas that are effective in reducing pathogens in the air and on surfaces. Air testing was performed with the MS2 bacteriophage, the test organism for ASHRAE standard 241, and methicillin-Resistant Staphylococcus aureus (MRSA). Surface testing was performed with SARS-COV-2 (Coronavirus COVID-19) and H1N1 (Influenza). Typical ventilation and filtration does not effectively remove disbursed pathogens from the entire facility, due to inconsistent air circulation and surface deposits of pathogens. Results: MS2 was reduced by 99.9%; MRSA was reduced by 99.9%; SARS-CoV-2 was reduced by 99.9%; H1N1 was reduced by 99.9%. Conclusion: This novel catalytic converter reduces a variety of pathogens in the air (99%) and on surfaces (99%), by actively disinfecting with the introduction of gaseous hydrogen peroxide. This active disinfection provides a strong solution for protecting the entire facility and its occupants.

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Permana, I., Lee, K., Wang, F.

Performance investigation of a novel positively or negatively pressurized operating room for infection control.

Journal of Building Engineering, Vol. **89**, (2024)

Operating rooms are often positively pressurized and maintained at a higher pressure than adjacent areas, preventing contaminated air from entering the sterile surgical environment. However, the COVID-19 outbreak has necessitated the construction of negatively pressurized operating rooms for contagious patients, preventing contaminated air from escaping into adjacent spaces. Therefore, this study developed a heating, ventilation, and air-conditioning (HVAC) system that can have a dual function pressurization, positively or negatively pressurized. High-efficiency particulate air (HEPA) filters were used for filtration. Then, a variable-speed driven (VSD) HVAC system modulates the pressure in response to environmental conditions when changing the pressure from positive to negative or while the door opens. At the same time, the air change rate (ACR) for dilution was implemented through the separated HVAC systems control schemes. Field measurements were performed to validate the results of a computational fluid dynamics (CFD) simulation, which was conducted to compare air particle distributions in a positively and negatively pressurized operating room and the effects of air curtains. The results showed that the positive pressurized operating room has a better airflow pattern and dilutes contaminants faster. In contrast, the negative pressurized system is the best solution for reducing the chance of airborne infection, particularly for contagious patients. Furthermore, utilizing air curtains can provide a better barrier against airborne contaminants, increasing the efficiency of contaminant control measures. The ventilation efficiency could be increased by approximately 10 % by applying an air curtain with a velocity of 0.5 m/s under both types of pressurization.

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Qian, Y., Ji, J., Xie, H., Jia, H., Tang, Y., Mu, Y.

Performance prediction of a novel disinfection-enhanced type Trombe wall with transverse fins.

Energy, Vol. **302**, (2024)

Trombe wall is an efficient passive solar heating system, while the utilization form of heated air needs to be expanded. Indoor microorganisms that can be transmitted through aerosol endanger the safety of human health. The fact that microorganisms can be thermally inactivated makes it possible to disinfect the air through Trombe wall. To expand and enhance the disinfection effect of the wall, extending the residence time of bioaerosols in the flow channel and raising the air temperature can be applied. Therefore, a transverse-finned-Trombe wall is proposed. Multiple physical field coupling is studied numerically. Migration,

inactivation, and deposition of bioaerosols are described by Eulerian method. The results indicated as follows: As fin height increases, the thermal efficiency first rises and then drops; the single-pass inactivation ratio rises remarkably with its value reaching 90.96 % and 66.98 % for SARS-CoV-1 and SARS-CoV-2 even at low irradiance level (400 W/m2) at a fin height of 35 mm. As fin angle increases from −45° to +45°, the thermal efficiency drops first and then rises. Optimal disinfection performance is achieved at α = 0°. The contribution of deposition to removal of infectious bioaerosols plays a significant role when the thermal inactivation is not strong.

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Link, M. F., Robertson, R., Claflin, M. S., Poppendieck, D.
Quantification of Byproduct Formation from Portable Air Cleaners Using a Proposed Standard Test Method.
Environmental Science & Technology, Vol. **58** n°(18), (2024), 7916-7923 p.

In response to the COVID-19 pandemic, air cleaning technologies were promoted as useful tools for disinfecting public spaces and combating airborne pathogen transmission. However, no standard method exists to assess the potentially harmful byproduct formation from air cleaners. Through a consensus standard development process, a draft standard test method to assess portable air cleaner performance was developed, and a suite of air cleaners employing seven different technologies was tested. The test method quantifies not only the removal efficiency of a challenge chemical suite and ultrafine particulate matter but also byproduct formation. Clean air delivery rates (CADRs) are used to quantify the chemical and particle removal efficiencies, and an emission rate framework is used to quantify the formation of formaldehyde, ozone, and other volatile organic compounds. We find that the tested photocatalytic oxidation and germicidal ultraviolet light (GUV) technologies produced the highest levels of aldehyde byproducts having emission rates of 202 and 243 mu g h(-1), respectively. Additionally, GUV using two different wavelengths, 222 and 254 nm, both produced ultrafine particulate matter.

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Abdolahnejad, A., Zoroufchi Benis, K., Mohammadi, F., Gholami, M., Raeghi, S., Rostami, R.*, et al.*
Risk assessment of airborne coronavirus-2 in wastewater treatment plant: comparing two different wastewater aeration systems.
International Journal of Environmental Science and Technology, (2024)

Numerous global studies have explored the fate of Coronavirus-2 within wastewater treatment plants. While research has confirmed virus transmission through aerosols generated in these facilities, the effect of different aeration methods on the potential transmission of this virus and other pathogens remains unclear. In this study, we aimed to examine the occurrence of Coronavirus-2 in air samples collected from two wastewater treatment plants employing diffused and surface aeration. Totally, 48 air samples (passive/active) were collected from 1.5, 10, and 50 m distances from both sequencing batch reactor and conventional activated sludge systems. Subsequently, a quantitative microbial risk assessment model was applied to evaluate the risk of Coronavirus-2 infection for staff. Results showed that all samples from the conventional activated sludge, and only 5% of samples from the sequencing batch reactor, were positive for Coronavirus-2 when tested at a 1.5-m distance from the aeration tanks. Quantification results revealed that the concentration of Coronavirus-2 in positive air samples from the CAS system, targeting the RdRp and N genes, varied from 15 to 239 and 15 to 119 genomic copies per liter, respectively. Quantitative microbial risk assessment revealed an annual infection risk of 3.6 × 10–1 (95% CI 1.8 × 10–7–1)/person/year for staff, which was 2–4 times higher than the suggested values by the United States Environmental Protection Agency (10–4/person/year). According to the results of this study, the diffused aeration system can be considered as a safer option due to the very low spread of pathogens.

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Zhao, D., Cheng, S., Tsui, F. R., Mathur, M. B., Wang, C.-H. J.
The Risk of Aircraft-Acquired SARS-CoV-2 Transmission during Commercial Flights: A Systematic Review.
International Journal of Environmental Research and Public Health, Vol. **21** n°(6), (2024)

The aircraft-acquired transmission of SARS-CoV-2 poses a public health risk. Following PRISMA guidelines, we conducted a systematic review and analysis of articles, published prior to vaccines being available, from 24 January 2020 to 20 April 2021 to identify factors important for transmission. Articles were included if they mentioned index cases and identifiable flight duration, and excluded if they discussed non-commercial aircraft, airflow or transmission models, cases without flight data, or that were unable to determine in-flight transmission. From the 15 articles selected for in-depth review, 50 total flights were analyzed by flight duration both as a categorical variable—short (<3 h), medium (3–6 h), or long flights (>6 h)—and as a continuous variable with case counts modeled by negative binomial regression. Compared to short flights without masking, medium and long flights without masking were associated with 4.66-fold increase (95% CI: [1.01, 21.52]; $p < 0.0001$) and 25.93-fold increase in incidence rates (95% CI: [4.1, 164]; $p < 0.0001$), respectively; long flights with enforced masking had no transmission reported. A 1 h increase in flight duration was associated with 1.53-fold (95% CI: [1.19, 1.66]; $p < 0.001$) increase in the incidence rate ratio (IRR) of cases. Masking should be considered for long flights.

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Lambiotte, Y. T., Elabbadi, A., Marouane, B., Besset, S., Roux, D., Ebstein, N., *et al.*
Routes of SARS-Cov2 transmission in the Intensive Care Unit: A multicentric prospective study.
Journal of Infection and Public Health, (2024)

Background The risk of SARS-CoV-2 transmission to health care workers in intensive care units (ICU) and the contribution of airborne and fomites to SARS-CoV-2 transmission remain unclear. To assess the rate of air and surface contamination and identify risk factors associated with this contamination in patients admitted to the ICU for acute respiratory failure due to SARS-CoV-2 pneumonia. Methods Prospective multicentric non-interventional study conducted from June 2020 to November 2020 in 3 French ICUs. For each enrolled patient, 3 predefined surfaces were swabbed, 2 air samples at 1m and 3m from the patient's mouth and face masks of 3 health care workers (HCW) were collected within the first 48hours of SARS-CoV-2 positive PCR in a respiratory sample. Droplet digital PCR and quantitative PCR were performed on different samples, respectively. Results Among 150 included patients, 5 (3.6%, 95%CI: 1.2% to 8.2%) had positive ddPCR on air samples at 1 meter or 3 meters. Seventy-one patients (53.3%, CI95%: 44.5% to 62.0%) had at least one surface positive. Face masks worn by HCW were positive in 6 patients (4.4%, CI: 1.6% to 9.4%). The threshold of RT-qPCR of the respiratory sample performed at inclusion (odds ratio, OR= 0.88, 95%CI: 0.83 to 0.93, p<0.0001) and the presence of diarrhea (OR= 3.28, 95%CI: 1.09 to 9.88, p=0.037) were significantly associated with the number of contaminated surfaces. Conclusion In this study, including patients admitted to the ICU for acute respiratory failure « contact route » of transmission, i.e. through fomites, seems dominant. While presence of SARS-CoV-2 in the air is rare in this specific population, the presence of diarrhea is associated to surface contamination around Covid patients.

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Gilham, E. L., Raja, A. I., Van Veldhoven, K., Nicholls, G., Sandys, V., Atkinson, B., *et al.*
A SARS-CoV-2 outbreak in a public order and safety training facility in England, June 2021.
Annals of Work Exposures and Health, (2024)

The public order and safety (POS) sector remains susceptible to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) outbreaks, as workplace attendance is typically compulsory and close physical contact is often needed. Here, we report on a SARS-CoV-2 outbreak with an attack rate of 39% (9/23), which occurred between 19 and 29 June 2021 among a cohort of new POS recruits participating in a mandatory 18-

week training programme in England.The COVID-OUT (COVID-19 Outbreak investigation to Understand Transmission) study team undertook a multidisciplinary outbreak investigation, including viral surface sampling, workplace environmental assessment, participant viral and antibody testing, and questionnaires, at the two associated training facilities between 5 July and 24 August 2021.Environmental factors, such as ventilation, were deemed inadequate in some areas of the workplace, with carbon dioxide (CO2) levels exceeding 1,500 ppm on multiple occasions within naturally ventilated classrooms. Activities during safety training required close contact, with some necessitating physical contact, physical exertion, and shouting. Furthermore, most participants reported having physical contact with colleagues (67%) and more than one close work contact daily (97%).Our investigation suggests that site- and activity-specific factors likely contributed to the transmission risks within the POS trainee cohort. Potential interventions for mitigating SARS-CoV-2 transmission in this POS training context could include implementing regular rapid lateral flow testing, optimizing natural ventilation, using portable air cleaning devices in classrooms, and expanding use of well-fitted FFP2/FFP3 respirators during activities where prolonged close physical contact is required.

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Fan, Y., Liu, J., Zhao, L., Wang, C., Moon, D., Song, S.
Study on the test accuracy of the high-air-volume purifier under different test chamber volumes.
Journal of Cleaner Production, Vol. **448**, (2024)

Due to the increasing local purification demand of public spaces during production processes, high -air - volume purifiers (HAVPs) with flow rates >800 m(3)/h have been increasingly applied in commercial and industrial spaces. Compared with clean air standards in the United States, Europe and other countries, relevant HAVP detection guidelines have not been standardized in most countries, and only Chinese and South Korean standards consider scaling HAVP test chambers. There remains a lack of theoretical and experimental HAVP detection studies. In this study, the airtight test chamber decay method was used, and the chamber size was increased by a ratio of 1:2:3 based on the original volume (30 m(3)). The effect of the test chamber volume on the HAVP accuracy was evaluated considering the amount of valid data, pollutant uniformity, and air cleaner position. Based on the results, the clean air delivery rate (CADR) deviation varied between 1.4% and 35.7% under the effect of the test chamber volume. The test accuracy was higher for the 60 m 3 test chamber, which is more suitable for HAVP testing. A new index based on the CADR - test chamber volume relationship was proposed, revealing that the air cleaner performance can be accurately measured when the equivalent clean air volume ventilation rate varies between 9 and 22 L/h. The upper HAVP detection limit should be considered in standard supplementation. The HAVP flow rate classification in Chinese standards should be refined. The results provide a reference for rapid selection of the appropriate test chamber volume for air cleaners with different flow rates, which facilitates HAVP application in industrial and commercial spaces.

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Dunn, K., Hamilton Hurwitz, H., Toledo, J. P., Schwaber, M. J., Chu, M., Chou, R., *et al.*
Summary of WHO infection prevention and control guideline for covid-19: striving for evidence based practice in infection prevention and control.
BMJ, Vol. **385**, (2024)

The World Health Organization (WHO) published the seventh version of the infection prevention and control guideline for coronavirus disease 2019 (covid-19) in December 2023. The revision and development process undertaken for this guideline consolidates and updates technical guidance developed and published at the height of the covid-19 pandemic (2020-21) into a single guideline, following WHO guideline development processes.12The updated guideline considered the current context of covid-19, the latest evidence supporting infection prevention and control (IPC) interventions, epidemiological trends, the emergence of variants of concern, population immunity, availability and uptake of vaccines, and indoor environmental conditions.This

article provides an overview of the guideline development process and summarises the current recommendations from WHO for IPC measures when caring for people with or managing covid-19 outbreaks.What you need to knowWHO has published an updated guideline for infection prevention and control in the context of covid-19In the healthcare facility, WHO recommends consistent application of standard and transmission based precautions to prevent SARS-CoV-2 transmissionIn community settings, WHO recommends mitigation measures to reduce the risk of SARS-CoV-2 transmission and its impactThe guideline development process for this consolidated guideline followed WHO methodology, including conducting systematic reviews of evidence and the use of Grading of Recommendations, Assessment, Development and Evaluation (GRADE) to assess the certainty of evidence and determine the strength of recommendations.12To develop the guideline, WHO convened a Guideline Development Group (GDG), which reviewed Population, Intervention, Comparator and Outcome (PICO) questions, prioritised outcomes, interpreted the evidence and assessed evidence quality, formulated recommendations, and established key considerations on behalf of WHO.12 The GDG included experts in IPC, epidemiology, infectious diseases, microbiology, paediatrics, water, sanitation, and hygiene, engineering and aerobiology, and civil society representatives.Thirty two research questions were identified and 17 systematic evidence reviews were commissioned.3 In addition, five …

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Nagata, K., Hasegawa, K.
Suppression of short-range exposure to infectious aerosols using multiple paths of midair ultrasound acoustic streaming.
Aerosol Science and Technology, Vol. **58** n°(7), (2024), 796-811 p.

One of the major infectious routes of respiratory diseases, such as COVID-19, is exposure to viral aerosols transmitted from an infected person over a short distance. Conventionally, plastic shields or personalized ventilation methods utilizing fans or jets to generate airflows between two facing users have been used to combat such short-range infection. Nevertheless, these methods entail several drawbacks: bulky apparatus hindering users' cooperative activities must be placed between them, the shields need frequent cleaning and block conversation voices, and the jet- or fan-based methods yield uncomfortably strong airflows hitting the user's face. Here, a new airflow-based strategy for suppressing aerosol exposure, which overcomes all the above inconveniences, was proposed. In this strategy, ultrasound-driven localized airflows called acoustic streaming, whose positions and traveling directions can be electronically controlled, was used. A prototype system composed of a group of phased arrays of airborne ultrasound transducers was created, and they were set behind the users to redirect paths of aerosols emitted from the user's mouth toward their upper and back sides. It is experimentally confirmed that the proposed system could reduce exposure to aerosols whose diameters are the same as ones emitted from people by 89.95% under a certain setup. By controlling the position and direction of the streaming, the proposed method can maintain its performance when users move their heads or bodies. The proposed system can virtually produce or delete programmable partitions in the air as desired, and can be integrated with other conventional methods for infection control.

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Park, J., Kang, D., Kim, H.-S.
Thermal characteristics of resistive heating composite panels for the interior parts of railway vehicles.
Adv Compos Mater, (2024)

The pandemic of highly infectious diseases like COVID-19 has highlighted the vulnerabilities of public transportation. In particular, railways are more vulnerable due to their dense environment, and the heating system used in winter is a major factor in increasing the transmission and risk of the virus. To improve the existing heating system, a study was conducted to develop a resistive heating composite capable of radiant heating. In this study, the applicability of heating elements, heating performance, and internal thermal

deformation factors of laminated panels and sandwich panels used as rail vehicle components were analyzed in detail to consider the actual application of this technology in the railway industry. The experimental results confirmed that both types of panels effectively heated above the target temperature (120degree celsius) in the heating element layer, demonstrating uniform heating characteristics. Additionally, sandwich panel is more affected by thermal deformation compared to the laminate panel. These experimental results are expected to serve as essential foundational data for the effective utilization, safety, and reliability considerations of resistive heating composite materials in real industrial environments.

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Minichiello, F., Naso, V.
Thermal Engineering and Building Energy Systems.
In: A Decade of Research Activities at the Department of Industrial Engineering (UniNa-DII): From Five Existing Departments to the Excellence in Research. Springer Nature Switzerland; 2024. 71-92 p.

This chapter summarizes the research activities and main outcomes of the groups engaged in Thermal Engineering and Building Energy Systems, in the decade 2013–2023. The research topics are typical of the sectors called “Fisica tecnica industriale” and “Fisica tecnica ambientale”.

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Jayakumar, N., Caffrey, V., Caffrey, M., Paprotny, I.
Towards real-time airborne pathogen sensing: Electrostatic capture and on-chip LAMP based detection of airborne viral pathogens.
Sensors and Actuators B-Chemical, Vol. **412**, (2024)

Considerable loss of life, economic slowdown, and public health risk associated with the transmission of airborne respiratory pathogens was underscored by the recent COVID-19 pandemic. Airborne transmission of zoonotic diseases such as the highly pathogenic avian influenza (HPAI) and porcine reproductive and respiratory syndrome virus (PRRSV) has caused major disruptions to domestic and global food security. Current ambient air pathogen monitoring systems involves the collection of air samples from indoor settings suspected of viral contamination, followed by subsequent processing of capture samples to determine the presence and species of airborne viral matter. Nucleic acid amplification techniques are considered the gold standard for pathogen diagnostics. Currently, the necessary extraction and purification of viral RNA from air collector systems prior to sample analysis is both time consuming and performed manually. A monitoring system with separate air sampling and biochemical detection procedures is prone to delay the response to emergent viral threats. In this paper, we present a pathogen monitoring system that overcomes these limitations related to extraction and purification of viral samples and lays the groundwork for a real-time monitor for airborne viral pathogens. We demonstrate a high flow electrostatic precipitator system, that uses small collection wells as counter electrodes for pathogen collection. Integrated reverse-transcriptase loop-mediated isothermal amplification (RT-LAMP) is used for detection of captured viral matter within wells. On-chip heating of collection wells is enabled by integrated planar heaters and small volumes of reagent (30 mu L) directly to the collection wells. We present the design of such a system and show experimental results that demonstrate the use of this device for detection of aerosolized SARS-CoV-2 virus like particles (VLPs), a model pathogen for SARV-CoV-2.

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Kaeophet, T., Dejchanchaiwong, R., Tekasakul, P., Phonsahwat, T., Khongprom, P., Ingviya, T.*, et al.*
Ventilation improvement for effective protection of healthcare workers in negative pressure airborne infectious isolation room from viral aerosols.
Building and Environment, Vol. **259**, (2024)

A negative pressure airborne infectious isolation room (AIIR) is the primary healthcare air contamination control system used for the treatment of severe respiratory infectious patients. Effects of the ventilation system configuration and conditions on airflow pattern, aerosol distribution and ventilation performance were investigated using computational fluid dynamics (CFD). The field measurement by SARS-CoV-2 environmental surface test was also conducted. The cycle threshold values from transcription polymerase chain reaction (RT-PCR) method showed inverse relation to the simulated number of particles trapped on the surfaces indicating a good agreement. Modification of the present AIIR to have alignment between air inlet and outlet where the aspect ratio of the air outlet, Width (W): Height (H) = 1:1 (Improved case: IC#1) showed a 78 % reduction of aerosol concentration in healthcare workers (HCWs) zones. Aerosol concentrations were increased when the openings of the air outlet were enlarged. Addition of air outlet led to large swirling air, resulting in more aerosols being trapped and suspended in the air. Results suggested that AIIR with alignment air inlet on the ceiling and air outlet at the wall over the patient's head with W:H = 1:1 be the most suitable configuration to maximize the ventilation performance and minimize exposure risk to aerosolized viral infection for HCWs. Air change rate plays a more important role than the differential pressure on the removal efficiency. The differential pressure value should be at least −2.5 Pa and the air supply rate 12 ACH for effective protection of HCWs in the negative pressure AIIR.

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Kikuta, K., Omori, S., Takagaki, M., Ishii, Y., Okubo, K., Ohno, Y.*, et al.*
Verification of Ventilation and Aerosol Diffusion Characteristics on COVID-19 Transmission through the Air Occurred at an Ice Arena in Japan.
Buildings, Vol. **14** n°(6), (2024)

This study is about a COVID-19 outbreak and ventilation measures taken against COVID-19 transmission through the air occurred at an ice arena in Japan. The ice arena has been known to have a deterioration of indoor air quality affected by CO, NO2 and so on, and a total of 172 persons were infected with SARS-CoV-2, including the players and the spectators related to an ice hockey game in 2022. Given the suspected transmission through the air as one of infection routes, the primary objective of this study was to investigate the COVID-19 outbreak to verify the ventilation characteristics and aerosol diffusion characteristics. Additionally, the possibility of COVID-19 transmission through the air and the potentially effective ventilation measures in an ice arena are discussed. It was determined that the virus-containing aerosol was released from a player in the ice rink and accumulated in the cold air spot. After that, it was highly possible that it diffused from the player benches to the spectator seats due to the players' movements under this unique air-conditioning and ventilation system. Judging from the results of genomic analysis, ventilation characteristics, and aerosol diffusion characteristics, the possibility of COVID-19 transmission through the air cannot be ruled out in an ice arena. The results of ventilation measures implemented in response to this problem confirmed that the integration of a lower-level exhaust fan based on cold air characteristics into the existing ventilation system is a relatively straightforward solution with the potential to be highly effective. While there is an option to refrain from using the ice arena in the event of an increased risk of mass infection during a pandemic, the findings of this study will contribute to an option to facilitate the smooth operation of ice arenas while implementing ventilation measures.

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